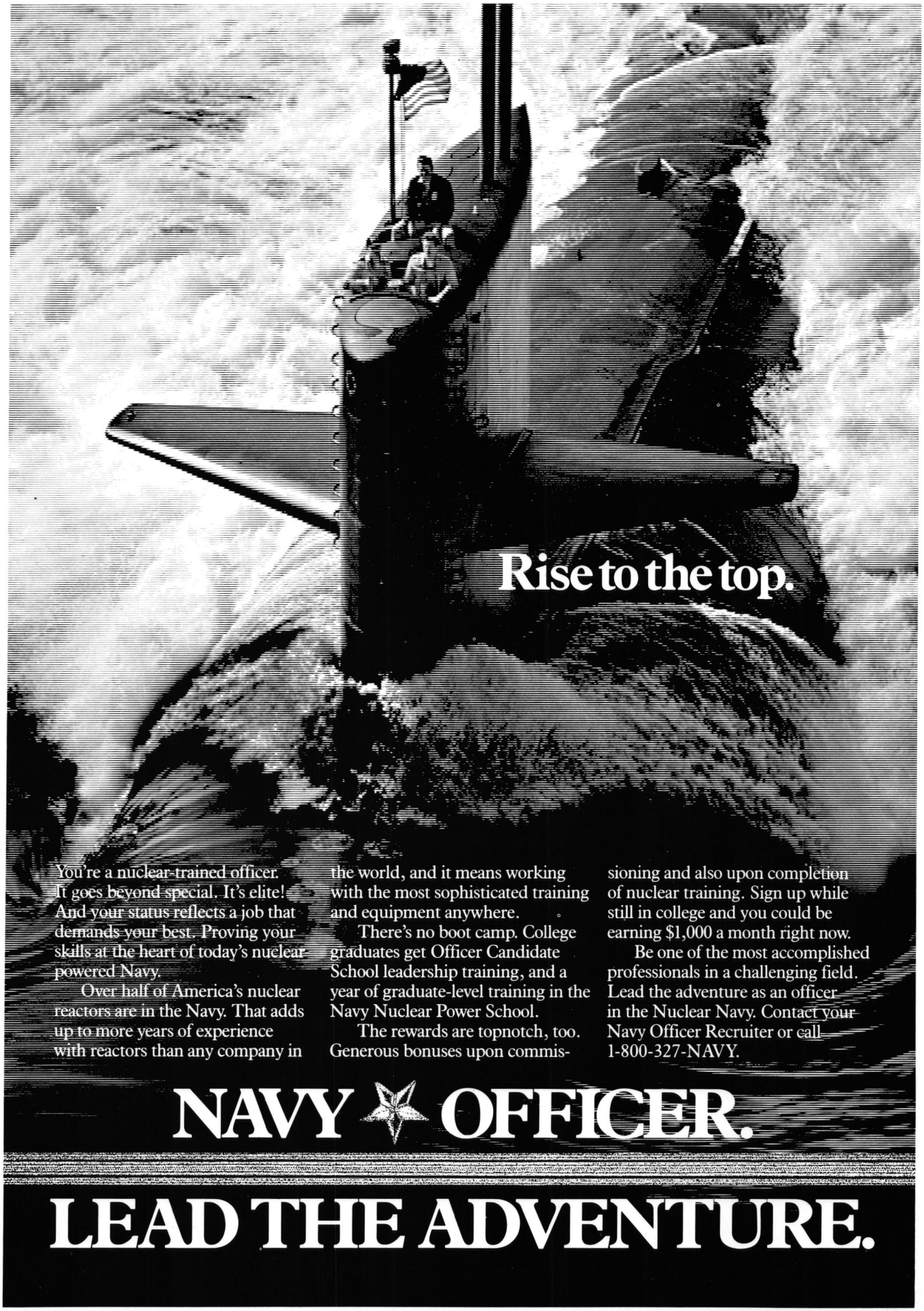
VOLUME 33, NO.2 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, SPRING 1986

# MECH ENGR CIV

## SHOULD NASA REEVALUATE THE SPACE PROGRAM?

PUBLISHED BY THE ENGINEERS' COUNCIL IN COOPERATION WITH THE ENGINEER ALUMNI ASSOCIATION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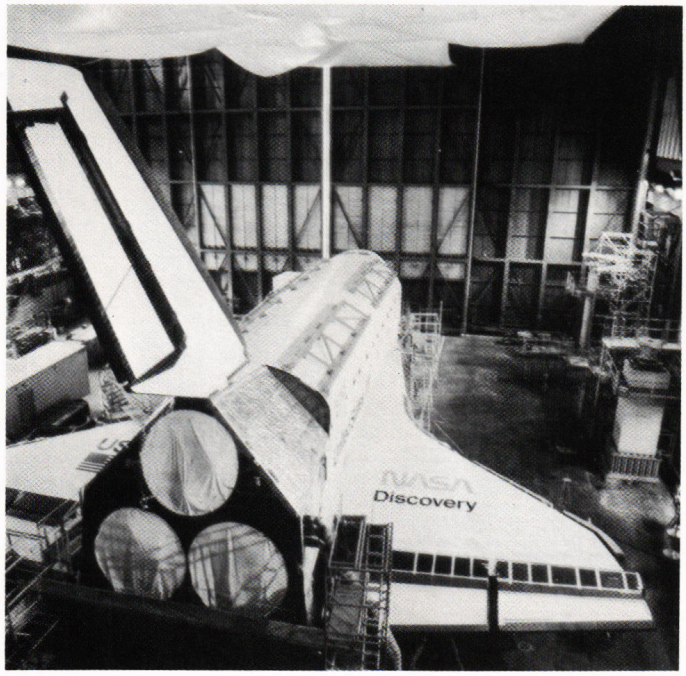



**COVER: The space shuttle Discovery sits in its hanger, grounded indefinitely until the fault that destroyed Challenger is corrected. Challenger's explosion was the first major catastrophe in 25 launchings of the shuttle, since 1981. By David Burnett for Contact. Courtesy of the New York Times Magazine.**

## The Challenger Incident: Did NASA Underestimate the Risks?

by Deirdre Maull

Seventy-three seconds after lift-off, on January 28th, the space shuttle Challenger exploded, arousing a nation and prompting a thorough and ongoing investigation. Just how much responsibility must NASA bear for this tragedy and what can they learn for the safety of future space flights? **4**

## "Space, the Final Frontier. . .": Voyager Goes "Where No Man has Gone Before"

by Lilimar Avelino and Swati Patel

Launched by NASA in 1977, Voyager 2 has just completed a recent encounter with the planet Uranus. It has sent back a wealth of fascinating information; information that will certainly change astronomers' view of the entire solar system. **9**

## NASA: Taking an Inside Look

by Rose Province

NASA has reacted to the recent Challenger tragedy by trying to, as much as possible, continue its day-to-day activities. Join us for a candid interview with a long-time NASA employee, and share our inside look into the workings of not only the shuttle, but all the elements of the space program. **12**

## Take a Ride into the Future on the Aerospace Plane

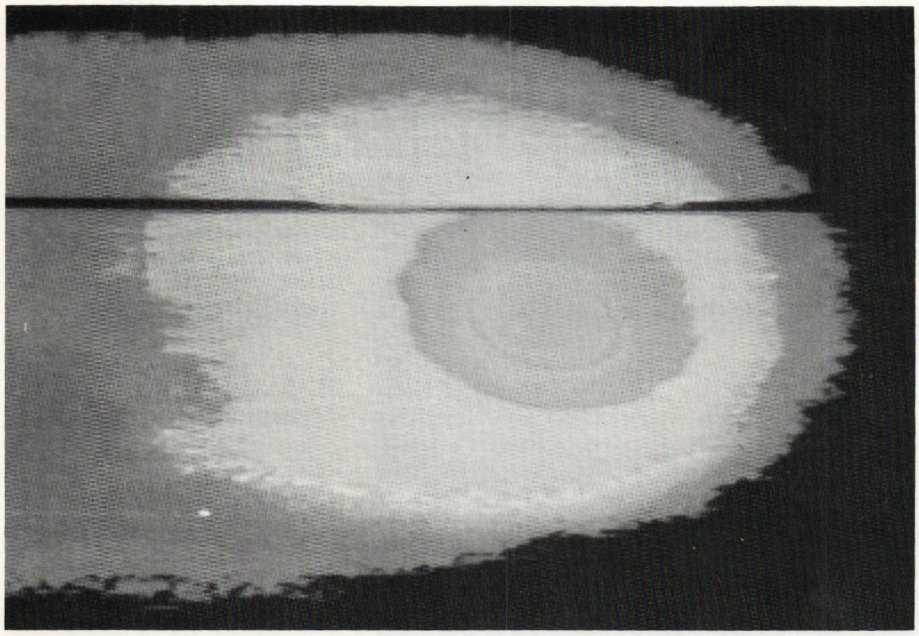
by April Stokes

President Reagan has enthusiastically backed the idea of a "space plane"—one which can travel from Los Angeles to Tokyo in two hours. Will this program get off the ground, and will it take a commitment by the military to do so? **15**

## Departments

Tech Briefs . . . . . 2
From the EAA . . . **18**
Campus News . . . **19**

***MECHELECIV has received a First Place Award from the Columbia Scholastic Press Association, Columbia University, New York City.**



*"Scientists now think that the core of Halley's Comet is like a dirty snowball, wrapped in dust." This computer photo shows the different layers of the comet, the core being the innermost sphere. Courtesy of* Newsweek.

## *Satellites Scrutinize Halley's Comet*

"LOOK, up in the sky! It's a bird, it's a plane, no it's Halley's comet! Unfortunately, this time around you probably need a telescope and some luck to see this once-in-a-lifetime visitor. Once every seventy-five years Halley's comet comes into our solar system and completes it's orbit around the sun. And this time scientists were ready for it.

The comet disappeared from our sight from early January to mid-February, as it made its trip around the far side of the sun. Though it disappeared from our earth-based sights, it became visible to another set of eyes in the heavens. The eyes were the ultraviolet scanner of the Pioneer 12, which has been orbiting Venus since December 1978. The Pioneer sent back clear and vivid photos to Earth as the comet neared its perihelion (55 million miles from the sun). When the comet was 93 million miles from the sun, Pioneer determined that the comet was losing around 12 tons of water a second, and, as it neared its perihelion, it lost around 40 tons a second. Since then, water loss has varied between 30 and 70 tons. Ian Stewart, chief scientist of the Pioneer Halley's project, estimates that the comet shrinks from 20 to 30 feet each time it passes the sun. So, after a few hundred more turns around the sun, the comet will disappear forever.

As the sun began to block the view of the comet from the Pioneer 12, a host of other satellites were sent to meet the comet. One of them was Giotto, sent up by the European Space Agency. It came to within 375 miles of the comet and sent back information that amazed astronomers. It showed the comet to be peanut-shaped, nine miles long and two miles wide. The scientists at the European Space Agency feel that the comet is not a dirty snowball, frozen gases wrapped in dust, as previously thought, but a snowy dirt ball, its core wrapped in dust. Giotto also found that the comet was pitch black. In the words of Dr. Horst Uwe Keller of the Max Planck Institute, the comet is so dark it is "like velvet—as dark as the darkest objects in the solar system." The information from Giotto suggests that the comet is actually quite warm and its blackness may be caused by an abundance of carbon on its crust. If so, this adds a point to the theory that a comet brought the germ of life to Earth.

Scientists will have to be satisfied with the information relayed to them from the various satellites. Anything else will have to wait until the comet returns to our heavens, in the year 2065.

*—Vaiji Ramaswami*

## Building the Space Station—Without Human Hands

"THE RECENT explosion of the space shuttle Challenger has raised new doubts about the effectiveness of the US's manned space program. One project it is sure to affect directly is the manned orbiting space station, scheduled to go up in the early 1990's. Plans for a permanent outpost in space hinge directly on whether or not the shuttle can reliably transport men and machinery beyond the limits of the Earth's atmosphere.

President Ronald Reagan has put his support firmly behind this $8 million project. It will house a crew of six to eight astronauts, who will live in its artificial, pressurized environment for up to six months at a time. NASA is hoping to make their stays as productive as possible by relieving them of many of the dreary, mundane chores necessary to keep the station functioning. To achieve

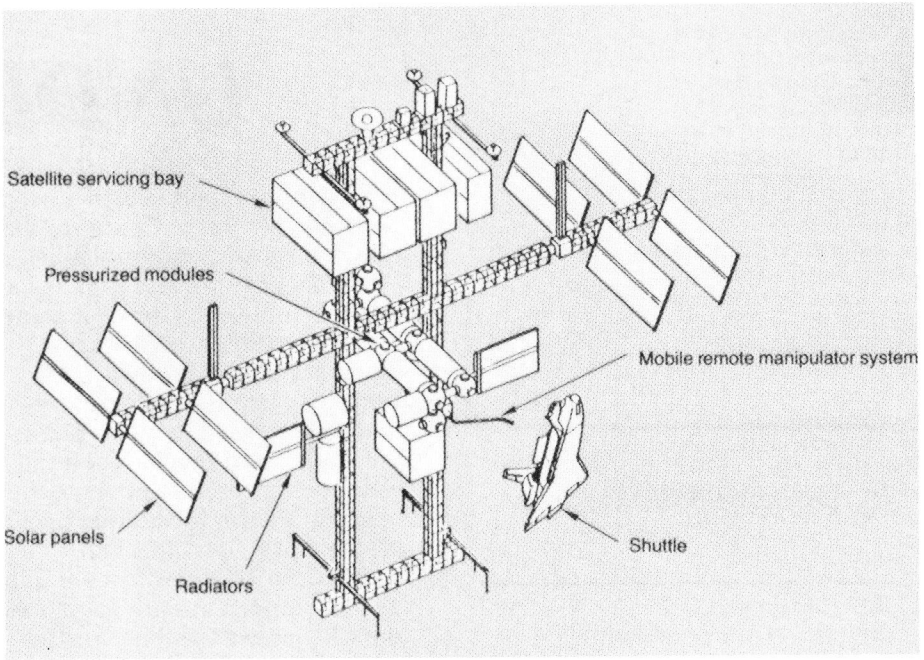
this goal, engineers and programmers are designing special robots to take over the tasks of satellite repair and maintenance, life-support monitoring, Extra-Vehicular Activities (EVA), and the construction of the station, itself.

The orbiting station's design calls for a series of modular living units to be connected by truss frames. Two of these modules, the **habitation modules**, will contain the crew's quarters, as well as eating and recreational facilities. Two more modules, the **laboratory modules**, will serve as headquarters for astronomical data-gathering, zero-gravity pharmaceuticals manufacturing, and many other types of experiments. All of these modules will be supported by the **logistics module**, which will serve as a kind of "warehouse" in space, housing food,equipment, stores, and spare parts.

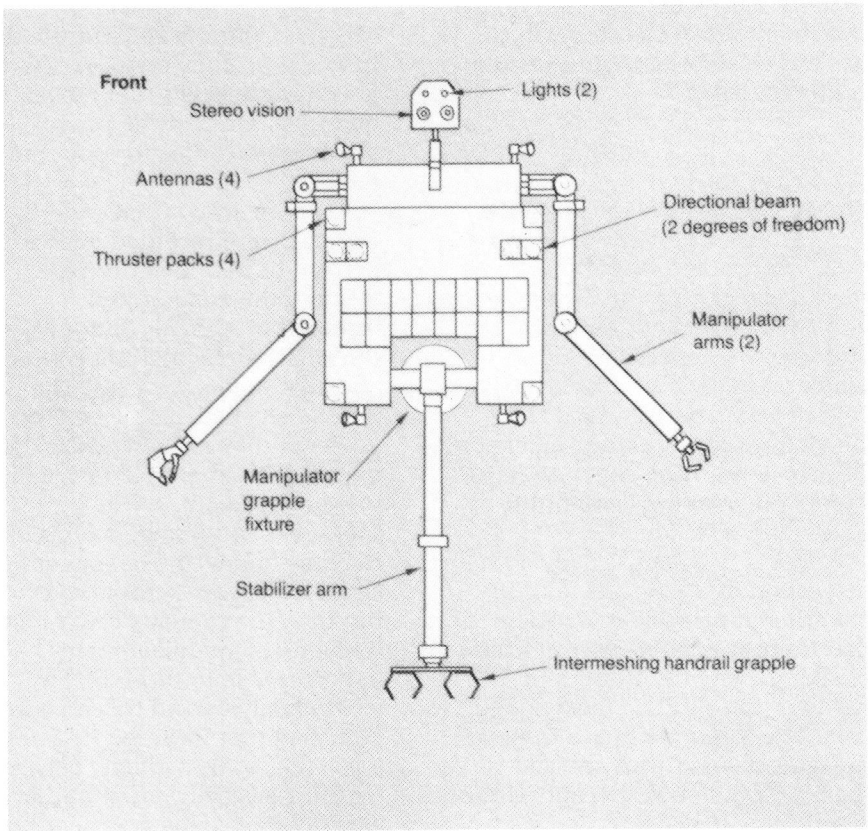
The space station will be assembled by joining many sections of truss to form a gigantic T-shaped frame, hundreds of feet in length. The various modules will then be hung on this frame. Joining the multitude of nine-foot truss sections would spell along and tiresome task for astronauts working in the unfamiliar environment of space. Robots, by contrast, could attach, tighten, and inspect all of these sections tirelessly, and with only periodic maintenance. Furthermore, there are human factors that enter into the picture. Astronauts can only spend a limited amount of time (roughly six hours) outside their craft, and, in order to avoid attacks of the bends, they have to breathe pure oxygen for *three and a half hours* prior to each trip.

One robot well-equipped for extra-vehicular jobs is Rockwell.'s Integrated Transfer Device, affectionately known as "Robin." "Robin" is designed to be fully self-propelled and independent, having its own guidance, navigation, control, communication, and sensory systems. Once "Robin" reaches the area it's supposed to work on,

*Continued on page* 17




*"The orbiting station's design calls for a series of modular living units to be connected by truss frames." The space shuttle, pictured below, is needed to ferry men and materials to and from Earth. Courtesy of* Mechanical Engineering.




*"Robin" uses its two human-like manipulator arms to perform the manual tasks an astronaut ordinarily would. Designed and built by Rockwell International, it is equipped to be fully self-propelled and independent, having its own guidance, navigation, control, communication, and sensory systems. Courtesy of* Mechanical Engineering.

# THE CHALLENGER UNDERESTIMATE

**by Deirdre Maull**

Born of the sun
they traveled a short while
towards the sun
And left the vivid air
signed with their honor.
—*Stephen Spendor*

"We have a report from the flight dynamics officer that the vehicle has exploded. The flight director confirms that."
—*Johnson Space Center*
*January 28,1986*

"AFTER four delays since the originally scheduled lift-off date of January 20, the Challenger was finally ready to go. It was Tuesday, January 28, and with the exception of the temperature being unseasonably cold, it was a perfect day. The Challenger stood waiting against a clear blue morning sky with its eager crew making last-minute preparations inside.

NASA's "ice team" made a final inspection of the Shuttle and its towering gantry. They decided that there was no danger of icicles breaking away on lift-off and harming the shuttle's heat-shield tiles. The Kennedy Space Center's director, having been advised there was little risk, permitted the countdown to continue.

"Four . . . three . . . two . . . one . . . and lift-off. Lift off of the 25th Space Shuttle mission . . . And it has cleared the tower." The public narration was then switched from the Kennedy Space Center to the Johnson Space Center in Houston.

The flight commentator's voice was lost amid the cheers of some 1,000 spectators watching on bleachers four miles away. At Concord High School, students who had repeatedly gathered in the auditorium finally had a chance to cheer in support of their teacher, Sharon McAuliffe, NASA's first "private citizen" in space. Controllers both at the Cape and in Houston intently monitored the Challenger's ascent, for the ascent is considered to be the most dangerous phase of the mission.

"Houston, we have a roll program," declared Commander Francis Scobee. "Roger, roll Challenger," acknowledged Mission Control. The Shuttle then turned gracefully on its back as the tank and the solid-fuel rocket boosters assumed the proper downrange course for entering orbit.

At 35 seconds, Challenger's engines were throttled back to 65 percent of full power to pass through the zone of high turbulence. At 52 seconds of flight, the engines reached full power and all systems were go. The Shuttle reached 104 percent of power and began to endure the region of maximum aerodynamic pressure (MaxQ).

NASA's long range television cameras followed Challenger as it streaked its way across the sky. But then the cameras caught an ominously unfamiliar sight, imperceptible to those below. NASA analysts said that an orange glow had first flickered just past the center of the orbiter, between the Shuttle's belly and the adjacent external tank. This was near the point where the tank is attached to Challenger. Milliseconds later, the fire had flared out and danced upward. Suddenly, there was only an immense fireball.

"SHAKING WILDLY out of control, the two boosters emerged from the conflagration, both clearly intact. They veered wildly apart, leaving yellow-orange exhaust glows and gleaming white trails behind them.

In Houston, the Flight Commentator was not yet aware of the images of disaster appearing on his TV monitor. His eyes were on the programmed flight data as he reported what would have been the readings from Challenger. His narration was incongruous as the fireball was being televised to millions of screens across the country.

There was a long pause as viewers stared in disbelief. The commentator announced, "Flight controllers are looking very carefully at the situation—obviously, a major malfunction." There was no data coming from Challenger. After another pause . . . " We have a report from the flight dynamics officer that the vehicle has exploded. The flight director confirms that."

"IN the crowd of spectators at the Cape, only a few experienced viewers immediately sensed the disaster. Many thought the explosion involved a normal separation of the boosters from the main tank and orbiter, but slowly people began to understand what had happened. A relative of one of the astronauts put his arm around his wife, as her smiles turned to tears. Schoolchildren began sobbing. In Washington, the President was informed of the tragedy and his State of the Union speech was cancelled. The country and the rest of the world mourned the loss of the seven crew members.

As reported in Aviation Week and Space Technology, NASA investigators have constructed the following accident scenario:

# INCIDENT: DID NASA THE RISKS?

*As dismayed and puzzled spectators watch, the Challenger illuminates the clear Florida sky with its fireball. The fork-like formation represents the exhaust trails of the two solid-rocket boosters, which continued to fly until they were detonated by range safety officers. Courtesy of* Discover.

**0.445 seconds:** The first evidence of black smoke was recorded as it was seen jetting from a point at or near the aft joint on the right solid booster.
**12 seconds:** The black smoke disappeared and the Challenger was well clear of the pad and completing its roll maneuver.
**58.774 seconds:** Tracking cameras detected smoke emerging again from the lower joint area of the motor.
**59 seconds:** The Challenger reaches maximum dynamic pressure (Max Q), calculated at 702 pounds per square foot, for this mission. An intense plume of flame emerged from the side of the right solid-fuel booster.
**60.164 seconds:** The right booster's thrust chamber pressure began to diverge from that of the left motor and flame continued to grow larger on the side of the motor.
**66.174 seconds:** Bright spots of fire become visible on the top of the motor, the side closest to the orbiter. This event indicates possible migration of the rupture around a large portion of the solid rocket motor joint.
**67.684 seconds:** The rate at which pressure had been increasing in the liquid oxygen inlet of the shuttle's main propulsion system began to slow. This was a possible effect of the completion of the throttle up sequence to 104 percent power on all three main engines.
**72.141 seconds:** Start of Challenger's breakup sequence. The vehicle was tugged to the right and data shows the magnitude of this force at 0.226 gees, or 0.226 times the pull of gravity. Investigators believe that the lower attach points for Challenger's right solid rocket booster were severed at this point either by the flame plume emerging from the rupture in the booster or abnormal stresses caused by the plume.
**72.201 seconds:** Rate gyro data from the right booster shows that

it was broken free at its lower attach point and its lower end started to move out from the vehicle, tilting its top toward the external tank.

**72.281 seconds:** Right booster rate gyro data shows, in addition to moving outward, the aft end of the solid motor started to pitch back toward Challenger where it may have struck and severed the right wing. It also seared the aft right side of the orbiter with a 2 million-pound thrust, 5600-degree Farenheit rocket plume. Analysis of Challenger debris indicates that aft right portions of the orbiter were severely burned.

**72.884 seconds:** The liquid oxygen and hydrogen inlet pressures to the main engines began dropping, indicating that rupture of the external tank had begun—or other lines, such as the large liquid oxygen line running down the exterior of the tank, had been severed.

**73.175 seconds:** A massive cloud of oxygen or hydrogen gas appeared beside the external tank, streaming from the point where the top right side of the tank was hit by the loose solid rocket booster. Some gas was visible along the bottom of the tank, indicating the beginning of a possible breakup in this area, as well.

**73.226 seconds:** A powerful explosion occurred near the forward booster attach point of the external tank as penetration of the tank by the top of the solid rocket booster caused rapid mixing of the liquid oxygen and liquid hydrogen propellants. Nonetheless, the orbiter continued to transmit data.

**73.399 seconds:** As the external tank was destroyed, massive propellant disruptions occurred in the main engines. The engines approached redline limits in their high pressure hydrogen turbopumps.

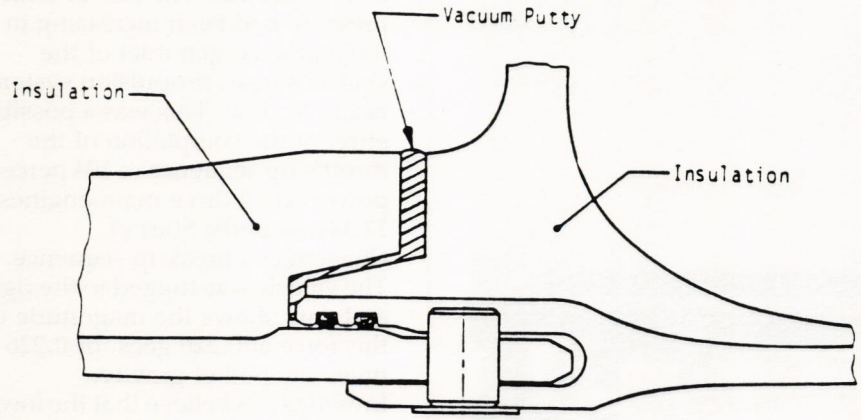
**73.534 seconds:** The Number 1 main engine shut down at the last moment before total vehicle destruction.

**73.605 seconds:** The last data was transmitted.

**110 seconds:** The right and left solid rocket boosters were destroyed by range safety officers.

## PRINCIPLE SUSPECTS ARE EXPOSED

The Presidential commission, with the technical assistance of NASA, is looking into several possibilities for the cause of the explosion. Principle suspects are the solid rocket boosters, the external tank, and the solid rocket booster struts. Investigation findings are developing rapidly. Following is a summary of the developments as they were known through March 15, 1986:




*NASA officials believe that defective seals in the field joint of the solid-rocket boosters may have triggered the Jan. 28 explosion of Challenger. The two small squares beneath the vacuum putty layer are the O-rings, which, due to abnormally cold pre-launch temperatures, may have failed, allowing hot gases to leak and ignite. Diagram courtesy of NASA.*

### Booster Seals

NASA is studying infrared sensor readings that showed surface temperatures of only 7 degrees Farenheit and 9 degrees Farenheit on the right booster, compared to 25 degrees Farenheit on the left booster. Westerly winds had flowed across and around the external tank before impinging on the lower right booster casing. This could have generated chilled wind eddies around the right booster all night, accounting for the colder temperatures. The infrared instrument used to record temperatures has been tested again to verify that its readings are valid. The tests showed that the background temperature of the sky, if visible in the sensor head, could have resulted in surface readings on the booster. The surface temperature readings have since been changed to 16 degrees Farenheit.

Seals in the field joints of the boosters are checked for integrity after the motor segments are joined by injecting 200-psi (200 pounds per square inch) air between the two seals (O-rings) to ensure they do not leak. The test positions the primary seal in such a way as to theoretically allow some blow-by of engine combustion products that are stopped by the backup seal until the primary seal moves into place soon after motor ignition. (However, such blow-by had been experienced in only two instances prior to this last mission.) If the primary seal is cold and therefore slow in moving into place, and the secondary seal is unseated, it is believed the motor would give off a puff of black smoke at the joint. The smoke would result from part of the seals eroding and the burning of grease and putty as the hot-flow penetrated the barriers. This is believed to be the cause of the black puff of smoke detected just before Challenger's lift-off.

The primary seal then would seat, temporarily halting any leakage through the joint, even though the seal may have been damaged seriously during motor ignition. This scenario would account for the motor functioning relatively normally until dynamic

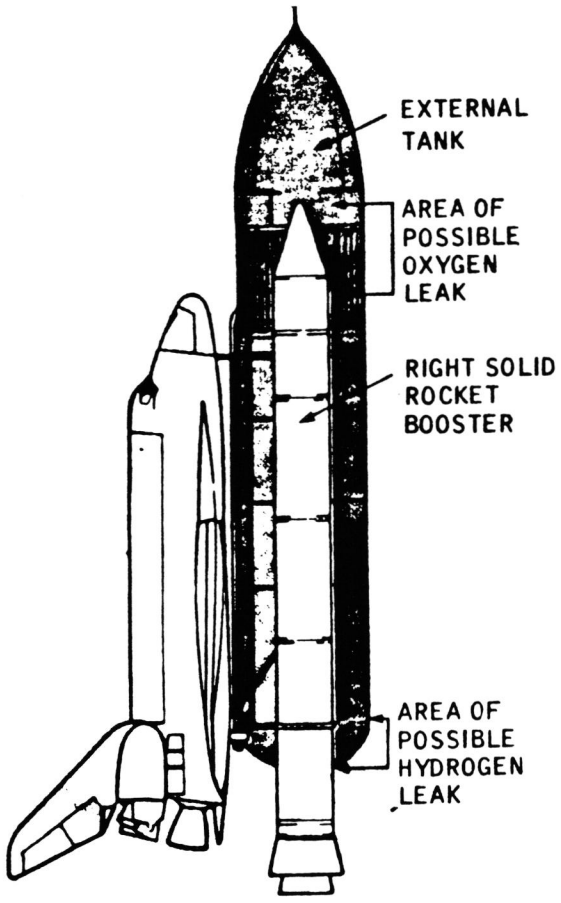
flow inside it gradually wore down the already damaged primary seal, leaving little to halt the escape of leaking exhaust gases later. When the vehicle reached the region of highest pressure, the motor joints were stressed even further. These stresses could have flexed the joint enough so that whatever original seal was left finally gave way.

"AT THIS stage of the Challenger's ascent, a high velocity plume emerged, causing the right booster to break loose from its lower external tank attachment point. The flame punctured the tank, yet the vehicle continued to fly on for several moments, prior to exploding. In response to this reasoning, experts have disputed NASA on the solid rocket booster flaw. Several solid rocket engineers have insisted that a solid rocket booster flawed in such a manner would have exploded right away, instead of flying on. "In my experience, a solid rocket machine that leaks almost immediately suffers a catastrophic event," said former Morton Thiokol senior vice president, Antonio Sovoca. Sovoca dismissed assertions that cold Florida weather might have rendered the solid rocket boosters' fuel vulnerable to vibrations that would generate cracks and flaws.

Harold W. Richey, a retired Thiokol president, and Billings Brown, a former engineer from Hercules, Inc., insisted that a serious leak in the rocket booster could not have lasted for the 14 seconds or more in which the photographs indicated a plume of flame. A leak would have destroyed the volatile booster within 5 seconds, said Brown. Brown, Richly and Sovoca pointed to observations that the boosters appeared to be flying normally after the Challenger's explosion.

**External Fuel Tank**

The possibility that during Challenger's countdown, an undetected leak of cryogenic liquid from the external tank froze the seals in the booster casing is now being intensely studied by NASA.




*The Challenger's external fuel tank may also have been a culprit in the disaster. According to one theory, supercold propellant from the tank leaked and spread over an area of the booster, freezing it and causing it to burst. Courtesy of* Aviation Week and Space Technology.

A cryogenic liquid leak that could chill an adjoining structure need not be large. Such a small leak would not appear in the tank pressure monitoring systems. The investigators are assessing whether a bad tank weld could afford a path for the liquid hydrogen to escape.

NASA engineers are studying whether it is plausible for a small leak of liquid hydrogen to vent from the aft dome section of the tank, pass through the tank's insulation, vaporize, and rise upward to chill the motor area that failed. The aft motor segment's attach point to the tank and its involvement in any chilling also are being assessed. A pinhole leak large enough to have a chilling effect on surrounding structures would not threaten the tank structurally, and would not cause an explosion unless subjected to an ignition source.

**Defective Struts**

A former USBI Booster Production Company engineer claims to have raised a warning nearly three years ago that the struts used to attach the solid rocket boosters to the external tank in the Space Shuttle system could fail.

USBI Booster Production Company, informed of the charge, rejected it by observing that the record of the strut performance speaks for itself. No problems have ever been encountered with the struts that hold the solid rocket boosters to the Space Shuttle's external tank. During development, test struts were subjected to stresses double those encountered in flight for 11,000 cycles.

Regardless, during Challenger's flight, the base of the right solid booster separated from the

KWANG-YONG QUEK

**Deirdre Maull** *is a sophomore, majoring in Mechanical Engineering. She is a recipient of the GW Engineering Honors Scholarship. Prior to enrolling at GW, she attended Georgetown University, in Washington, D.C.*

external tank, rotated outward, and then crushed the upper right side of the tank, causing it to explode. This means that the lower attachment strut separated from the external tank, although NASA investigators said the failure was a secondary effect of a problem with the right solid booster.

RUSHING TO JUDGMENT?

Reports coming out of the investigation of the Space Shuttle disaster have raised the possibility that the catastrophe was caused by a problem—inadequate seals on the booster rockets—that NASA knew about some time before. There are two ways to react to this information. One is to be outraged that NASA could be so reckless. The second is to be thankful that NASA assesses potential risks so painstakingly. The first response is probably the most natural. But the second is much more reasonable. Perhaps we should welcome the news that the Commission investigating the explosion had found conclusively that the Shuttle blew up because of a risk NASA had knowingly taken.

This would mean, first, that engineers could hone in on a clearly identified problem, correct it, and get the program back on track. It would also show that NASA had not been blind-sided in its engineering. It would be testimony to NASA's thoroughness. The Shuttle is surely one of the most exhaustively scrutinized machines in the history of technology. The worst that might be said, based on evidence so far, is that NASA may have undercalculated certain risks — the threat of cold weather to the seals, as well as the chance of a backup seal failing — but the testimony also shows that these risks were analyzed carefully, not dismissed out of hand or ignored. NASA also had reason to be confident on the now suspect primary O-ring. The official who waived the usual requirement for effective backup seals on the solid rocket boosters noted that primary seals had always worked in tests and that the Air Force Titan 3 rocket, with only a single seal, had never experienced a failure. A more cautious person might not have granted the waiver, but that level of caution becomes paralysis. A space program demanding such risk-free performance would never have been able to get off the ground.

"WHATEVER the outcome of the investigation, we must not permit the accident to interfere with the further exploration of space. Yes, there was a defect in the design of the spacecraft, and yes, it is receiving a great deal of attention. Scores of engineers are busy redesigning many features of the shuttle, those under suspicion, as well as some that are not. But to stop now would defy the essence of being human—to reach out and extend beyond ourselves. As the futurist William Renfro noted, "To understand [humanity's] exploration of space, we have to imagine the movement of life millions of years ago, from swimming in the sea to breathing air on land. If we had been there, we might have looked to our future on land to imagine seeing farther and moving faster—but from that wet world we could not, as Arthur C. Clarke noted, have imagined "fire." To be content is to remain earthbound and to not venture farther is "thinking like a fish."

The vision of the future of space is not one vision for all mankind, the Western world, or even this country. Rather, our vision for the future of man in space is the collective personal vision of millions of us—each his own part of it. The small step taken by [the astronauts] toward space was a giant leap—proof that our dream can come true. Our journey may be one of 1,000 miles, the first step a stumble, the way difficult, but the journey has begun." Or, as President Reagan more succinctly put it, "Nothing ends here." ■

**Author's Update:** At publication time, tests have virtually ruled out such causes as defects in the Challenger's fuel tanks, damage from flying debris, and load stresses. The most likely cause of the accident appears to be a failure of the seal in the field joint between the two lower segments of the right solid rocket booster. Failure of the seal set off the following possible sequence of events:

(1) Superheated gases escaped through the field joint;
(2) The gases cut the aft struts attaching the booster to the external tank;
(3) The booster pivoted on the forward strut, striking and rupturing the external tank;
(4) The ruptured external tank poured forth liquid hydrogen, which immediately became gaseous;
(5) The gaseous hydrogen ran down the side of the external tank to the jet of superheated gases escaping from the booster joint and ignited;
(6) The flame front raced up the trail of the external tank, causing it to explode.

Investigators have narrowed the possible factors contributing to a seal failure to five: damage to the seal during assembly; delay in closing of the main seal; stiffening of the putty; the presence of ice in the joint that might have forced the seal out of place; and a breach of the main ring due to environmental factors, including cold and humidity.

*—Deirdre Maull*
*31 March 1986*

# "SPACE, THE FINAL FRONTIER . . . ": VOYAGER TRAVELS "WHERE NO MAN HAS GONE BEFORE . . . "

**by Lilimar Z. Avelino & Swati Patel**

"ONLY science fiction, right? Wrong, aeronautical technology has advanced past picture story books and unbelievable tall tales of exploring the vast universe to bring to our eyes a vision of the galaxies. Star Trek's adventures are becoming closer to reality through NASA's advances in space mechanics.

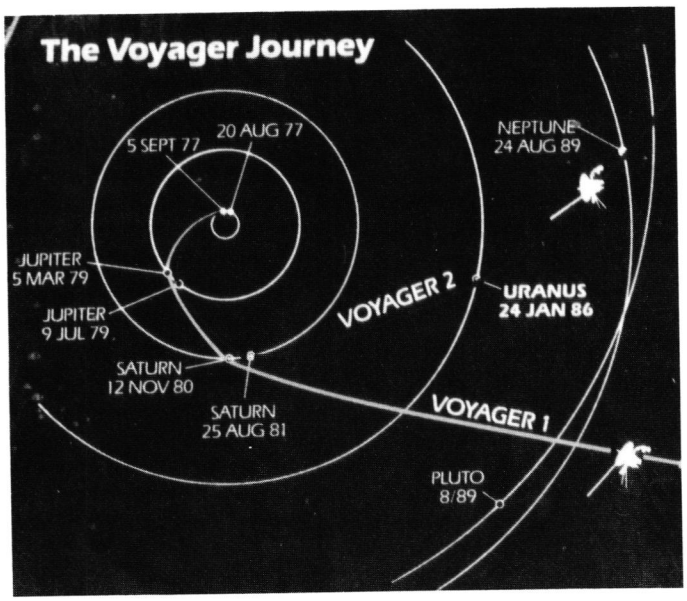
Two of the most dynamic of these advances are the two Voyager spacecrafts. Launched in 1977 with its sister ship Voyager 1, the Voyager 2 spacecraft hurtles two billion miles away through the icy darkness of space. Its lifetime mission is to explore our solar system and search through the unknown void beyond it. In 1979 and 1981, both Voyagers revealed stunning pictures of Jupiter and Saturn. With the use of the gravitational boost of Saturn, Voyager 1 now flings toward the boundary of our solar system, while Voyager 2 just completed its latest encounter, from November 4, 1985 to February 25, 1986, with the aqua-colored planet, Uranus.

PROBLEMS WERE NEVER TOO LARGE TO OVERCOME

Voyager's journey toward Uranus was not without problems. After leaving Saturn, one of the two radio receivers ceased to function, while the other receiver had a bad circuit. Also, the scanning platform that holds the camera became semiparalyzed. Although the platform was restored in two days, the people at Jet Propulsion Laboratory (JPL) took no chances and pointed the camera at where Uranus would be during its encounter.

Voyager 2's cameras also had to contend with the problems of darkness. The Uranus planetary system is probably one of the darkest in our solar system, since it receives only one three hundred and fiftieth as much sun as Earth. In addition its dark rings and dark moons complicate the problem. In order to compensate for this, ninety-six second exposures were necessary to ensure quality photographs.

"DUE to the relative distances of the outer planets from Earth, a radio signal from Uranus would be four times weaker than one from Saturn. It takes two hours and forty-five minutes for signals from Earth to reach Voyager 2. Sending a picture even takes as long as six to thirteen minutes. Consequently, before the important rendezvous, antennas were set up all over the world to catch every detail sent back.




*Voyager's next encounter will be with the mysterious planet Neptune, in August, 1989. It will pass Pluto, the outermost planet in the Solar System, later that month, after which it will journey on to other stars and (maybe) other worlds. Courtesy of* Popular Mechanics.

KWANG-YONG QUEK

**Swati Patel** *is a sophomore majoring in Electrical Engineering. She is interested in the field of medical engineering and would like to go to medical school or do graduate study in biomedical engineering. Swati finds any kind of scientific research especially challenging and rewarding.*

## DISCOVERING HIDDEN BLACK RINGS

The first great discovery about Uranus came in 1977 when a star's light behind Uranus was being blocked by what astronomers discovered to be nine virtually black rings. Voyager 2 verified the number of rings, and measured the particles when passing through the ring plane. Before the encounter, scientists speculated that the dark rings were probably made of carbon-rich material, like that covering asteroids, or of methane ice darkened by radiation.

Unlike Saturn's bright and broad rings with an abundance of fine particles, Uranus' rings are narrow and consist largely of dark "boulders" that encircle the planet every eight hours. One theory is that these "boulders" are remnants of a shattered large moon. Fine, dust-like particles like those in Saturn's rings are swept from the planetary system by Uranus' wobbling magnetic field.

As Voyager 2 approached the brightest and outermost Epsilon ring, it found a pair of moons inside and outside the rings exchanging gravitational energy with ring particles to keep them tightly bunched. A faint tenth ring inside the Epsilon ring as well as a faint 1,900-mile band within the innermost ring added to the list of Voyager's discoveries.

## URANUS EXHIBITS STRANGE ORBITAL TILT

One of the most peculiar aspects about Uranus is its orientation. Its rotation axis is perpendicular to those of other planets, while being parallel to its orbital plane. Scientists speculate that a large earth-sized object somehow tipped Uranus on its side in its early history.

In order to study the effect of Uranus' strange orientation, scientists waited for Voyager's examination of the planet's magnetic field. At first, there seemed to be no hint of radio emissions that usually announce the presence of a magnetic field from millions of miles away. If Uranus had no magnetic field, that would explain the presence of dark rings—that is, the solar wind would constantly erode away ice on the large particles making up the ring, rendering them virtually invisible.

Finally, however, on January 15th, 1986 a huge outburst of radio signal announced the presence of a magnetic field. The people at JPL hypothesized that the magnetic field would be roughly aligned with Uranus' rotational axis, but once again Voyager proved them wrong. In reality, the magnetic axis is approximately 60 degrees from the rotational axis. Voyager may have caught Uranus on the verge of reversing its polarity, like earth once did 700,000 years ago. So, as the rings and moons revolve around the planet, they experience a burst of charged particles and a constantly charging magnetic field.

## VOYAGER FINDS MYSTERIOUSLY HIDDEN MOONS

Before the actual Uranus flyby, Voyager discovered 10 small moons, in addition to the 5 large ones visible from Earth. One of these, 1986U7, is nestled among Uranus' 9th and 10th rings. The moons added more mystery to the unraveling picture of Uranus' planetary system. There were increasing signs of geological activity. For example, the exotic Miranda has valleys and layered deposits like Mars, depression faults like those of Mercury and the ground terrain of Jupiter's moon Ganymede.

Miranda also possessed some unlikely features. A series of dark lines forming a stack of pancakes, a big V-shape with concentric cracks and parallel grooves simulating the shape of a rectangular race track; all signifying the confusion and banging that this moon has taken. Scientists conclude that Miranda was probably shattered by collisions with asteroids, comets, or other moons.

"URANUS's other moons have their own peculiarities. Oberon contains a three-mile high mountain. Titania has a long groove or valley along its visible surface. Ariel reveals ice flora patterns like fresh frost and resembling tracks left by terrestrial glaciers. All these moons feel the powerful tug of Uranus' magnetic field. Only the moon Umbriel defies the pattern. Umbriel is dark, bland and has some meteorite craters. Somehow, it is seemingly unaffected by the Uranian gravity. The reason why still remains a question.

Most of the JPL scientists wonder why these moons are dark, since the major component was thought to be ice. Just as with

KWANG-YONG QUEK

**Lilimar Avelino** *is a sophomore, majoring in Electrical Engineering. She wants to coordinate these studies with a Computer Science minor or a Premedical Engineering major. Lilimar is also TECH BRIEFS Editor of MECHELECIV and works as a co-op student for the Naval Research Lab, in Washington, D.C.*

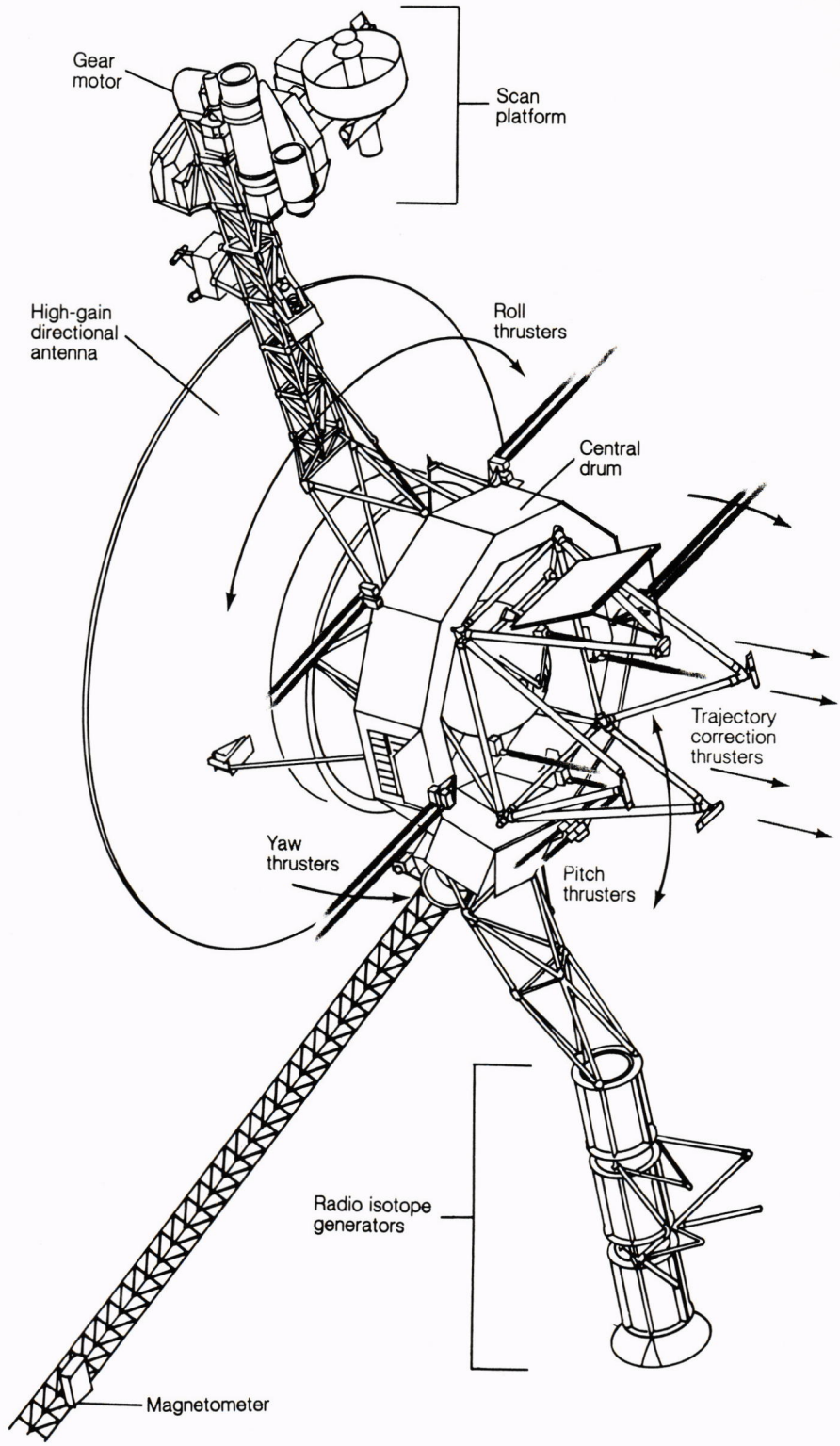
the rings, two reasons arise. First, ice with methane breaks down to form reddish black organic compounds. Second, falling dust, comet nuclei and certain meteorites are black. Whatever the reason, this dark planetary system definitely baffles the minds of scientists.

## CHARTING UNENCOUNTERED TERRAINS

Traveling past the moons, Voyager 2 went to investigate the thick, blue-green atmosphere of Uranus. Voyager calculated one planetary revolution to be 17.3 hours. Once they knew how fast the planet rotated, they could know more about the atmosphere and weather. The planet has a core of rock and liquid with a deep ocean of hot water laced with ammonia. It is covered with a blanket of hydrogen, 10%-16% helium, and scattered methane. On the south pole, the sun shines for 42 years straight. Here it is also redder due to interactions between ultraviolet sunlight and the planet's atmosphere.

Due to its great distance from the sun, the weather at Uranus is naturally cold; the temperature is approximately −343 degrees Fahrenheit from the pole to the equator, except for a "cold collar" at 30 degrees latitude. Astonishingly, low altitude winds blow at about 100 miles per hour, while high altitude winds move around the planet at 220 miles per hour.

The Voyager, uncovering new moons, dark rings, hidden magnetic fields, mysterious surfaces, strange orbits, unbearable weather conditions, and so on, has provided us with increasing scientific knowledge. But is this the end of the line for Voyager 2? Not at all—Voyager 2 will travel further on its mission to uncover Neptune's hidden secrets (this is expected near August 24, 1989), and then on to other galaxies. Such pioneering advances by NASA in space exploration should be commemorated, for with machines such as Voyagers 1 & 2, space is not the final frontier, it is the boundless, endless frontier . . . ■




*Voyager is a small, but incredibly complex, package of equipment-. Sensitive cameras and scanners exist side-by-side with rocket thrusters for controlling and correcting course and trajectory. Courtesy of* Discover.

# NASA: Taking an Inside Look

*by Rose Province*

"WHAT is it about a tragedy that always attracts people's attention? Before the Challenger disaster on January 28,1986, NASA's missions and projects had slowly been pushed to the back pages or reduced to a short few paragraphs in the nations leading newspapers. The news of a shuttle launch was announced with hardly a "bat of an eye", and the success of each mission was taken for granted. But finally,in the last few weeks before the scheduled Challenger Mission, Americans were starting to get excited again, thanks to the amazing photographs coming back from Uranus, and the prospect of a "teacher in space," the first "ordinary citizen" ever on a manned space flight. Then with the tragedy came the shock. We had forgotten the risk, that men and women on these missions were still pioneers in an unexplored frontier facing all the dangers that accompanied it.

There has been much arguing and finger-pointing in the weeks since the unfortunate accident. Almost everyone,though, is in agreement that one of the major causes of the catastrophe was lack of communication in the decision making process. Some believe that there was too much pressure to keep the schedule of launches, or that a cost factor was involved resulting from NASA's low budget.

Instead of all the finger-pointing, I believe that what NASA really needs is a lot of support from the government and from every American, so that the space program can get back on its feet and running smoothly and safely. Over the last twenty years NASA has kept the United States on top of the worlds's space technology and that is where we want to stay.

## LOOKING INSIDE WITH CHRIS SCHERER

As a co-op student last summer, I worked for NASA at Goddard Space Flight Center in Greenbelt, Maryland. There I worked in the telecommunications branch, which is an small, but important, part of the big picture.

The key to success when enormous projects are involved, is a lot of people with their own individual tasks, working together smoothly and efficiently towards a challenging goal. In addition there must be good management and much planning. There are people at NASA who are right now making plans for projects that will be reality ten years from now.

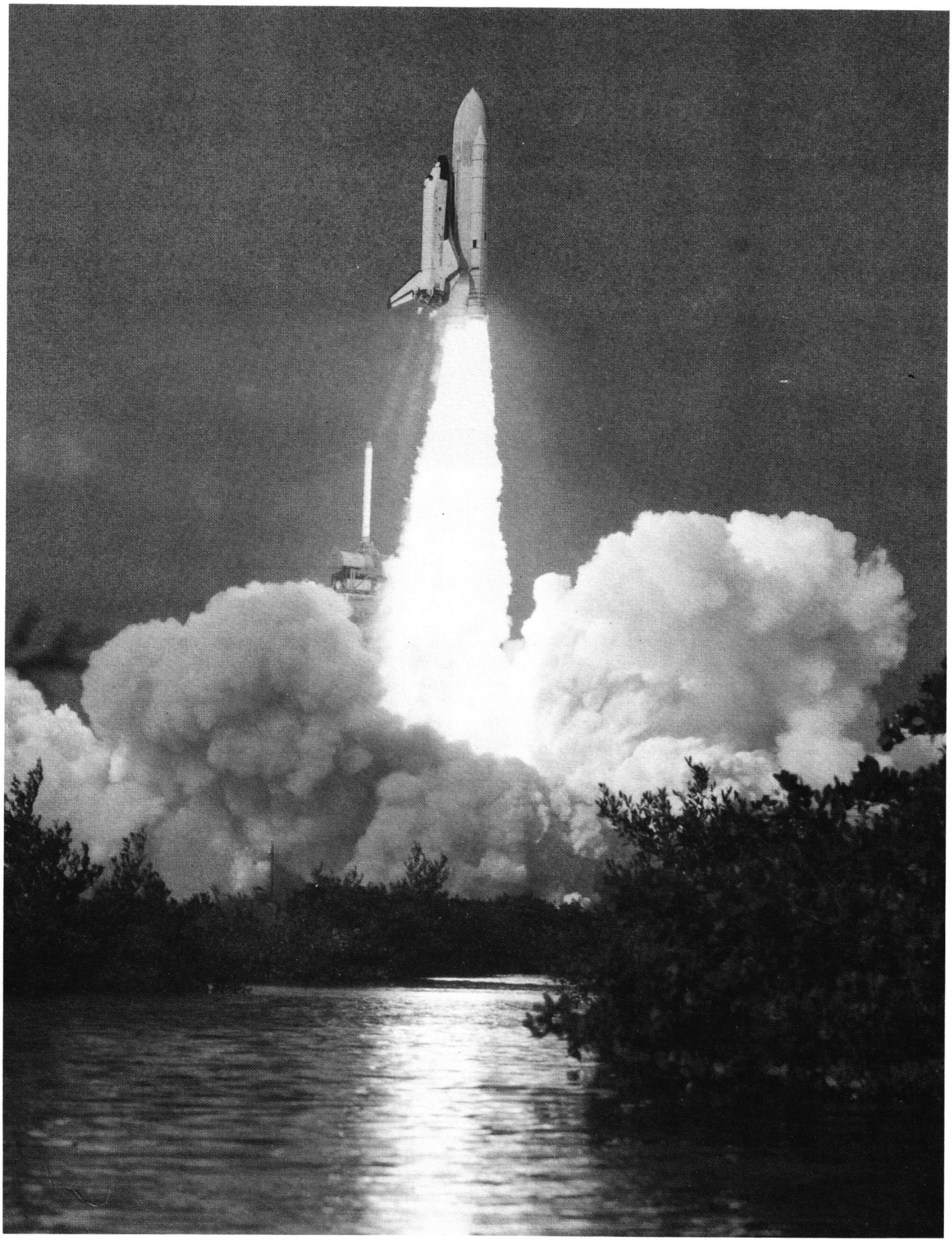
I talked with Chris Scherer (Aerospace Technologist Mathematician) who has been a dedicated member of the NASA team for 18 years, which is a large part of NASA's history. The National Aeronautics and Space Administration (NASA) was formally opened on October 1,1958. At this time, the country was just beginning to realize the importance of a space program and the fact that the U.S. was trailing behind the Soviet Union in its space technology. Throughout Scherer's career, NASA has gone through a considerable amount of growth and change. Beginning in 1966, there began what Scherer called the "Apollo Buildup". During this time, there was a lot of publicity for NASA,including an advertising campaign to attract interested scientists and engineers. But with the Vietnam War came RIFs (Reductions In Force) and large cutbacks in NASA's budget.

"IT seemed to Scherer that the space program was the only thing really moving forward in the dreary 70's. Planetary exploration began with the Viking landing and the Voyagers. Satellites were developed and improved with a wide variety of practical uses. They gave scientists geodetic measurements that could provide more information on the size and shape of the Earth, thus providing more accurate mapping. Satellites also send back pictures that you see on the weather forecasts, everyday on the six o'clock news. An example of these is the weather satellite GEOS, which Scherer is currently involved with. It has a geostationary orbit - that means the satellite is in orbit at the same speed as the Earth's rotation, so that it is able to stay fixed over one area on the earth. Satellite pictures are much more accurate than radar and enable meteorologists to see a lot more. An additional service that the satellites provide is communication from space ship to groundstation, and for satellite television and phone services.

## INTRODUCING THE SPACE SHUTTLE

The space shuttle program got off the ground with the maiden voyage of the first space shuttle Columbia, on April 12,1981. The shuttle ushered in a "new era of space flight", routine flights into space in a reusable vehicle. Shuttles can carry men and women of average physical condition because it undergoes 1/3 of the acceleration of previous rockets.

The value of the Space Shuttle is in the payload it carries. A previous Challenger mission carried "Getaway Special" canisters, these held experiments



*With a brilliant cloud of smoke, a space shuttle leaves humanity 's earthly boundaries and launches toward the heavens. Photo courtesy of NASA.*

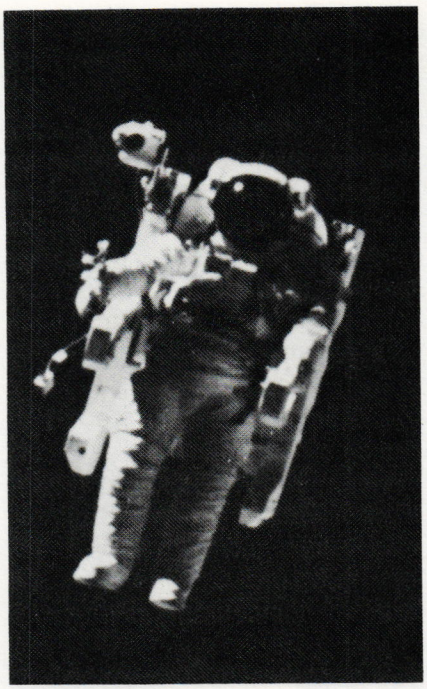
in physics, biology, technology and material science sponsored by high school and university students, Goddard Space Flight Center, U.S. Air Force, and GTE laboratories. Also a Mono disperse Latex Reactor was on board, a mini-factory for making microscopic latex spheres of uniform size for use in medical and commercial applications. The list goes on, including an experiment involving a new technique for separation of protein fluids by their diverse electric charges - a process called **electrophoresis**, and for the second time in the shuttle program live rats were carried on board in an Animal Enclosure Module (life support cage). The rats were there for tests to see whether or not weightlessness relieves the symptoms of arthritis.

DISCUSSING THE CHALLENGER TRAGEDY

When asked if he felt that there were any changes NASA should make in the face of the shuttle tragedy, Scherer had a few ideas. One was to increase the usage of the Delta Rocket, a spacecraft employed in unmanned missions, for launching orbiting satellites and thereby lighten the payload of the shuttle. Scherer is currently involved in a Delta I 80 project to

COURTESY, ROSE PROVINCE

**Rose Province** *is a Sophomore, majoring in Electrical Engineering, with a Pre-med Option. She has received an Engineering Honors Scholarship and has been on the Dean's Commendation List. Rose currently works for NASA, as a co-op student, at the Goddard Flight Center in Greenbelt, Maryland.*



*It's lonely out there! An astronaut takes a solo trip in a Manned Maneuvering Unit (MMU), a jet-powered backpack in which he/she can fly freely, completely detached from the spacecraft. Courtesy of NASA.*

which Goddard supplies communication support. The Delta rocket is nicknamed the "NASA Space Transportation Work Horse," and it has gone through many changes and developments. Since its first launch in 1960, Scherer feels that with the use of the Delta rocket, the shuttle's use could be lessened to special missions where astronauts are needed. In Scherer's words, "Why use a jet plane when a helicopter is all that is needed." He felt that the tight schedule of the shuttle launches was a contributing factor to the disaster.

SURVEYING THE PRESENT, PLANNING THE FUTURE

NASA is now in the midst of many new exciting projects. A project being researched now that Scherer is excited about is the "Space Plane". He feels that it will soon make the shuttle "passe." The Space Plane has many advantages over the shuttle. While the shuttle must carry an oxygen tank, the Space Plane is able to extract oxygen from the air. The Space Plane will be smaller and lighter than the shuttle and would not need solid rocket boosters for fuel. The problem that must be solved concerning the Space Plane is making an engine that will withstand the intense heat involved.

"CURRENTLY being tested are the Manned Maneuvering Units (MMU). Using the Space Shuttle as a base, Bruce McCandless and Robert Stewart became the first people to fly in free space and detached from their vehicle. The jet powered MMU weighs 136 kilograms, and it is worn like a backpack by a space-suited astronaut, who can put it on and remove it unassisted at a special flight support station. It runs on batteries and 24 small nitrogen gas thrusters that direct motion.

The space telescope is another important technological feat. It is an optical telescope that when placed in orbit, enable scientists to see deep into space—seven times farther than before.

Finally, the Manned Space Lab, a top priority in NASA planning, will hopefully be completed by 1992 (a tentative date). This Space Lab will entail bigger cameras, more sensitive radios, and will be manned 24 hours a day; thus enabling us to carry out many innovative experiments in the space environment, such as research on solar cells, welding in space, and many more.

It is unfortunate that the Space Shuttle accident will cause a delay, but since the tragedy is something no one involved would want to repeat, NASA will learn from its mistakes. Despite the setbacks, there is no question in Scherer's mind that the space program will move forward. ■

TIM MOORE

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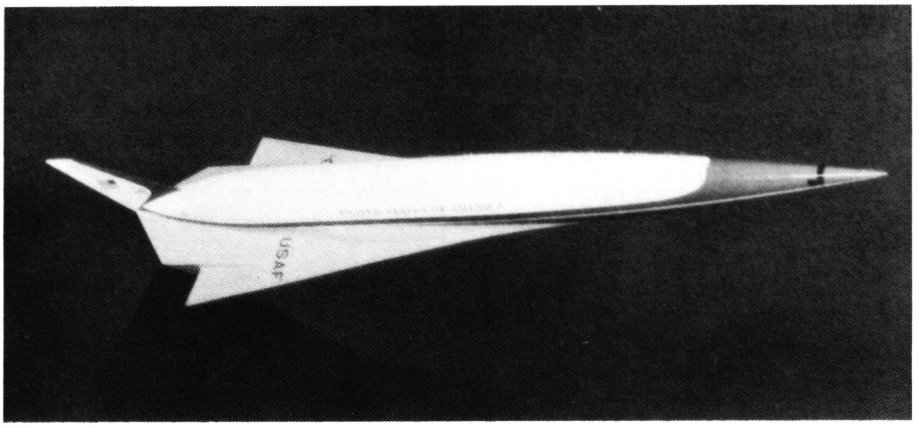
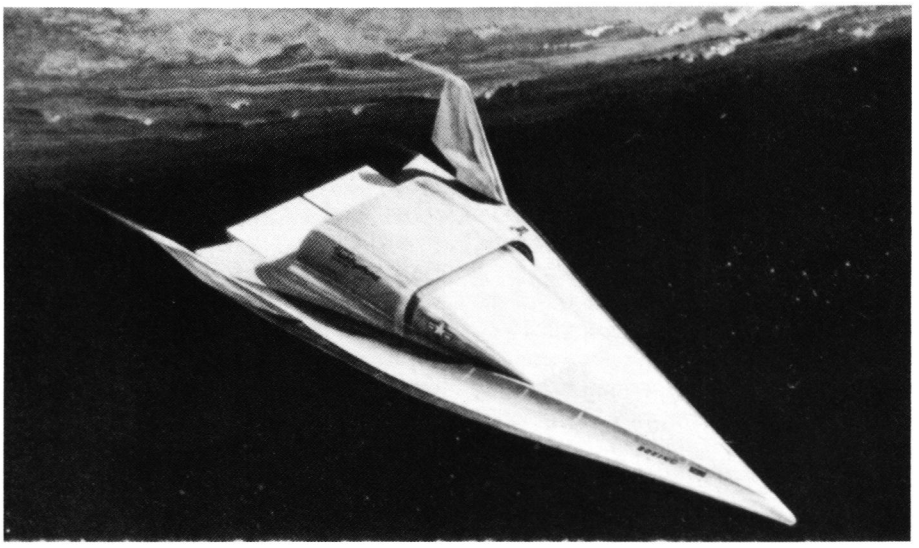
# Take a Ride Into the Future On the Aerospace Plane

**by April Stokes**



*Engineers are still trying to work out the final design of the aerospace plane. The Air Force version (top) borrows its shape from an existing supersonic plane, the Concorde, while Boeing's (bottom) displays its raised wing flaps. Photos courtesy of the US Air Force and Boeing.*

"Passengers, could I please have your attention. Good afternoon and welcome aboard the AirJapan Flight 306 from Los Angeles to Tokyo. Our estimated in-air flying time is two hours. Once we are in the air, you can view the earth from the TV monitors throughout the cabin. Once we stabilize at Mach-5 (five times the speed of sound), the flight attendants will be serving snacks and beverages. Since we are preparing to depart, please take time now to check your seat belts. If this is your first time flying with us, you may notice our seats are slightly different from conventional airlines. That is because these are specially designed to help your body adjust to the G forces acting on it during takeoff and landing. Thank you for flying AirJapan . . . "

"THE conversation above is hoped by many to be commonplace for air travel in the 21st century. But what type of aircraft is involved? Well technically, it is called a "transatmospheric vehicle" (TAV), but it is more commonly known as the aerospace plane.

## THE AEROSPACE PLANE FINDS SUPPORT

Ex-White House science advisor George Keyworth is a main supporter of the aerospace plane. Last July, he made a funding plea before the House Science and Technology subcommittee. In spite of budget cuts, the aerospace plane idea is gaining support in the armed services and science committees of Congress. In addition, the National Aeronautics and Space Administration (NASA) and the Pentagon's Defense Advanced Research Projects Agency (DARPA) are among the enthusiastic possible civilian and military users.

The projected funding plan is a three-year, $50 million project, funded by the Defense Department and NASA. Design plans involve developing a Mach-25 plane that could take off from a conventional runway and fly into outer space. This TAV would then be adapted for a Mach-5 300 or 500 passenger civilian transport.

## SELLING POINTS FOR THE AEROSPACE PLANE

As a military project, the aerospace plane's major selling point is its ability, in theory, to provide a cheaper alternative to

the space shuttle for carrying payloads into orbit for the Star Wars defense system. It might also be used as an attack plane against enemy bombers.

A commercial version of the plane would not necessarily go into space, but would fly across the globe at unthinkable speeds. By comparison, the Concorde supersonic transport flies at just over Mach-2, or 1,450 miles per hour. This craft would vastly reduce travel time, a key factor to improving service to such countries as China and Japan. Air travel to these and other Pacific Rim countries is thought to be the area of greatest growth over the next decade.

## RECENT TECHNOLOGIES MAKE THE AEROSPACE PLANE CREDIBLE

Three technological areas have made recent advances that make the aerospace plane credible. The advances include the creation of lightweight, heat-resistant materials for use in the airframe and engine,"air-breathing" propulsion engines, and improvements in computer power that allow the integration of components in the design stage. This aircraft will require, more than any other aircraft before it, that the engines, the fuel, the tanks, and the frame interact while in flight.

The make-or-break factor of the aerospace plane appears to be the propulsion system. At low speeds (takeoff to Mach-4), the engine would use turbines to compress the air before it mixes with fuel in the combustion chamber. At higher speeds, the air propulsion engine will be used. The tremendous force of the incoming supersonic airstream, itself, would become the compressor. The engine would require a fast-burning fuel and very precise control of the supersonic airstream. Two different engines are needed, because air propulsion engines only begin to work at speeds over Mach-4. In the last three years, NASA has tested the air propulsion engines at its Langley research lab up to speeds of Mach-7. The engine has not been flight-tested as of yet, and getting the complete engine system to work in harmony will be a major challenge.

"BECAUSE OF the extreme temperatures generated by atmospheric friction, a hypersonic craft would also require high-strength, high temperature-tolerant materials and elaborate cooling measures. One possibility is to use cryogenic fuels, such as liquid hydrogen, as both coolants and propellants. The fuel, flowing through the aircraft's skin, would cool the surfaces as it vaporized, before being injected into the combustion chamber.

## OLD TECHNOLOGY FINDING NEW INTEREST

A hypersonic aircraft is a return to the days of rocket planes like the X-15 of 1958, which still holds world aircraft records for high-altitude flight at 354,000 feet and a speed of Mach 6.7. In fact, the air propulsion engine now in development at Aerojet General Corp. of Sacramento, CA was actually invented in 1949. One of the points stressed by Keyworth in his testimony before the subcommittee was that the technology needed for the aerospace plane is already here, just waiting to be used.

## SOME UNANSWERED QUESTIONS REMAIN

These are many questions yet to be unanswered about the aerospace plane. These questions include:

- Can materials to be used for the frame sufficiently withstand continued use in an air propulsion engine?
- Can the frame withstand the very prolonged periods of high temperatures?
- Will the complete engine system be able to work?
- Will there be any environmental problems due to the aerospace plane during takeoff and landing?
- Does it make sense to build a hypersonic plane before building an advanced supersonic plane (i.e., faster than the Concorde, but far slower than the proposed aerospace plane)?

## HOW LONG DOES THE AEROSPACE PLANE HAVE A FUTURE?

Short term research for the aerospace plane will definitely continue, if only because of the military's interest. However, the Gramm-Rudman-Hollings resolution, which aims to end the federal deficit in five years, will take its toll on technological programs scheduled to start in 1986. The aerospace plane may well be one of its victims. It would appear certain that the conceptual and engine research proposed by NASA and DARPA will go forward, even at the expense of trimming programs that already exist. All in all, despite its uncertain future, the aerospace plane's speed and convenience would make it a transportation marvel we would be foolish not to develop. ■

KWANG-YONG QUEK

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## Space Station—

*Continued from page 3*

it secures itself by grabbing onto the piece with its bottom foot. It then uses its two human-like manipulator arms to perform the manual tasks an astronaut ordinarily would. Robots like "Robin" could be very useful once the station was actually operational—they could scurry around making "household"-type repairs and also make longer "field trips" to orbiting scientific platforms.

Robots could hold the key to effective satellite repair, a job astronauts in the shuttle have struggled with every time they've tried. Damaged or malfunctioning satellites will be guided into designated **satellite servicing bays** on the station. In these bays, they will be worked upon by both fixed and free-moving robots. One such bay is designed so that the entire apparatus can revolve 360 degrees around the damaged satellite, allowing the robot to reach it from any angle. These robots would use their pre-programmed "intelligence" to repair the satellites on their own, with minimal human involvement.

In another related area, on-board computers will be used to supervise and carry out the complicated procedure of spacecraft docking. Software systems, currently being tested by Lockheed, operate somewhat like present-day flight simulators. However, they must be even "smarter" than flight simulators, because they must worry about the motion of *two* spacecraft simultaneously, instead of just having one craft avoid the trajectories of all the others. To begin with, these systems are fed a database of navigational rules and procedures. It then uses these, along with sophisticated computer graphics and solid-modeling techniques, to achieve a perfect rendezvous in space.

These above-mentioned systems are a long way from being perfect. As Mike Wiskerchen of Stanford University explains, the traditional NASA approach is to first define a problem and then build the hardware to achieve the desired objective. This type of system, though, requires a lot of user-designer communication—between the programmer who formulates the instructions and the astronaut who must direct the robot on a day-to-day basis. Tom Sheridan of MIT suggests the development of a standardized language for these applications. He claims it would alleviate this problem by giving programmers the capacity to classify the robots' tasks, according to their degree of complexity. In addition, as Bill Park of SRI points out, future satellites will have to be designed with the consideration that they can be repaired and maintained by existing, orbiting robots.

*—Daniel L. Briller*

# Should We Continue the Space Program?: GW Students Air their Views

"A TRADEGY that most considered "unexpected" has become the topic of everyone's conversations . . . but how do the engineering students of George Washington University view the space shuttle malfunction on the future of NASA's manned space program? To answer this question, MECHELECIV's inquisitive staff hit the pavements of GW and conducted a brief survey. From the 70 engineering students surveyed, the questions and their results include the following:

(1) *Due to the many previously successful space shuttle launches, did it ever occur to you that a malfunction could result in this launch?* 76% of the students surveyed said 'yes,' while 24% said 'no.'

(2) *Do you feel that NASA should continue its manned space program?* This question resulted in a surprising 90% 'yes' and a 10% 'no'. When asked why or why not, varying answers were provided by our fellow SEAS members:

Some of the 'pros' included:

- "The manned space program is vital to the development of new technologies, for it provides the country with national security and prestige."
- "It is important to a human intellect to interpret act on phenomenon which might otherwise be misconstrued by machines."
- "The quest for outer space knowledge must not be stopped, for it holds much that is beneficial to earth."
- "Mistakes, although tragic, do happen; just be a lot more careful—people don't stop driving after car accidents—listen to experts—safety before speed."

On the other hand, the 'cons' included:

- "The government should take care of more serious problems first like the problem of the homeless."
- "Until communications within NASA are strengthened and every risk is properly considered, the manned space shuttle program should not continue."

(3) *Which program do you feel is most important for the U.S. space program to pursue:*

- Space Shuttle
- SDI - Strategic Defense Initiative Research
- Space Station
- Unmanned Space Exploration (like Voyager)

This question resulted in the following statistics:
33% out of 94 people answered Space Exploration,28% - Space Shuttle,20% - SDI, and 19% - Space Station.

From the 70 engineering students surveyed at GWU, the future of NASA's space program seems assured, yet, also from the opinions of these educated people, NASA must consider safety number one in their long list of priorities before any further advances are made into outer space.

*—Lilimar Avelino, Swati Patel, and Rose Province*

## On to May 4th—The Survivors of '86 Make It!

"I want to be an engineer." So said 305 incoming freshmen in the fall of 1982. Now, if all goes well, about 120 seniors from the School of Engineering and Applied Science, SEAS, will be donning caps and gowns at the spring commencement.

As incoming freshmen in September of 1982, most students declared a major. Let's look at how many declared what and how many lucky ones will be declared graduates on May 4th.

The original list included 135 in Electrical Engineering/Computer Science (EE/CS), 37 in Civil Engineering (CE), 42 in Mechanical Engineering (ME), 13 in Systems Analysis and Engineering (SAE), and a total of 78 who couldn't make up their minds.

Now who is graduating from what? There will be 81 graduates in EE/CS, 22 in CE, 14 in ME, 4 in SAE, and those 78 "non declarees" probably either made up their minds or had them made up for them.

All totaled, only about 40% of those enrolled made it. These statistics ranged from a high of 60% in EE/CS to only 31% in SAE. These percentages do not include the undecided students. The figures would be much lower — about 10% — in each discipline if they were included.

So, our hats come off to the graduating seniors—they are truly survivors.

*—Jeff Winbourne*

## Engineers' Council Elects New Officers

Akbar Khawaja was declared newly elected President of the Engineers' Council (86-87) in recent E.C. Elections. Akbar is a doctoral student in Expert Systems & Information Systems Management at the Engineering Administration Department of GWU. Last year Akbar Khawaja has contributed his skills & services to many student committees. He was the Chairman of the Senate Student Affairs Commitee and also represented SEAS as its graduate senator.

The following officers were also elected:

M. Akbar Khawaja
President
Khalid A. Juhany
Vice-President
Dipo Alam
Treasurer
Imran Ul Haque
Secretary
Talal M. Bakhsh
Asst. Secretary
Demetrios Demetriou
Chairman, Engineers' Week
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Senior Rep.
Albukhary Bin Awang
Junior Rep.
Nathan Markides
Sophomore Rep.

Akbar and his team plan to offer: effective coordination for its member organizations, professional seminars, technical exhibitions & workshops, student/faculty forum, awards of excellence, engineers' council newsletter and quality service at D.H. House.

*—Akbar Khawaja*

COURTESY, AKBAR KHAWAJA

*Mr. Akbar Khawaja was recently elected President of the Engineers' Council for 1986-87.*

## What's Happening in the EAA

*(Provided by Mary O. Jones, compiled and written by Jeff Winbourne)*

NORRIS C. Hekimian has become the newest GWU alumni trustee. A graduate of the Class of '49, with a degree in electrical engineering, he is the founder of Hekimian Labs. He served as president of the company from 1969 to 1981, at which time he changed his position to focus more of his time on research and development. He now serves as Hekimian Labs' vice president for research and development.

In 1976, Mr. Hekimian was the recipient of the GWU Alumni Achievement Award. And in 1984, he won the Engineer Alumni Service Award.

## Head of SDI Program to Speak at GWU

LT. GENERAL James A. Abrahamson will be the guest speaker for this year's Frank Howard Lecture Series, on April 15th. Lt. General Abrahamson, who is the head of the Strategic Defense Initiative Organization, and formerly was in charge of the Space Shuttle Program, will speak on, "The Strategic Defense Initiative-Scientific Challenge."

The event, which is open to the public, will be held at Lisner Auditorium April 15, at 8 p.m. Admission is free.

QUICK NOTES

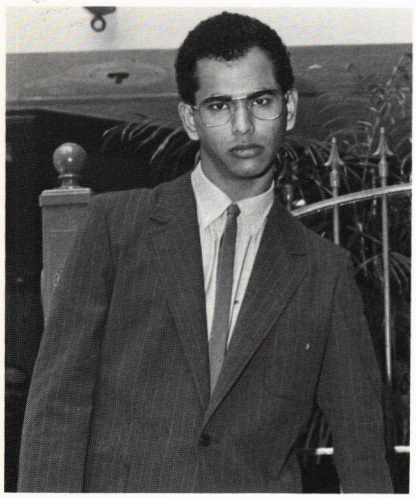
- The Alumni Association will hold its annual reception at the French Embassy on May 9th. Tickets are $15.00 per person.
- Reunion Weekend will be on June 7th.
- And just so you don't forget, the Annual EAA Picnic will be held on September 27th, at Carderock, Maryland. More details will follow in later issues.

■

## Tau Beta Pi Announces Award Winner

KHALID JUHANY, undergraduate recipient of TBPi's Outstanding Sophomore of 1983-84 award, exemplifies the mark of excellence in the SEAS Department at George Washington University. As a dedicated mechanical engineering student, Khalid's activities are not limited to academic achievements, because he extends his support to professional and community oriented groups such as ASME, AIAA, Engineers' Council, Pi Tau Sigma and Tau Beta Pi.

Many students believe grades are the only factor in determining a candidate for TBPi's award, but that is not always the case. Khalid feels his undergraduate research on thrust augmenting ejector systems for marine propulsion, under the direction of Dr. J.V. Foa and Dr. C.A. Garris, might have been one of the contributing factors in TBPi's decision. Student research at universities is usually limited to the graduate level, but here at GW, undergraduates are welcomed, even encouraged, to participate.



COURTESY, KHALID JUHANY

*Mr. Khalid Juhany acts as Student Coordinator for the Engineering Honors Research Program.*

Khalid is also active as student coordinator for the Engineering Honors Research Program. Under his efforts this past year, he was able to convince seven new individuals to participate in this program. This select group conducts research in many facets of engineering, always striving toward improving the world in which we live.

Outside of his family's supportive role and his religious outlook, the Ministry of Higher Education in Saudi Arabia, has especially aided Khalid's academic efforts. The Saudi Arabian government, which gave Khalid a scholarship to study in the U.S., is allowing him the opportunity to continue his education on a graduate level toward a doctorate. Khalid also feels that Dr. Foa and Dr. Garris have greatly contributed to his achievement, here at GWU.

When asked how another student might accomplish the task of receiving TBPi's award, Khalid replied, "You must start from the basics. I would encourage each individual to set his/her own goals. These goals should be chosen so that one may achieve his best results, not just to win an award. You must have trust in yourself and use your capabilities, because many students have it but don't use it."

One day Khalid dreams it might be possible "to build a huge research facility in a third-world country where all the top scientists, engineers and doctors throughout the world may practice towards a cooperative goal of peace and tranquility." At the present time, he plans to give a presentation at the University on his research project covering the subject of "how the Harrier's (a British fighter jet) consumption of energy to achieve vertical/short takeoff landing capability compares to our newly developed XF V12 A (U.S. Navy)."

*—Armen A. Sahagian*

EULER V. UY

*Dr. David B. Newman, a new faculty member in EE/CS, "moonlights" as a patent attorney and writes a monthly column "Communications and the Law."*

## Will Space Station Law Be Written by a GWU Professor?

Do you want to meet someone who uses his time efficiently? Meet Dr. David B. Newman; he's not only a new member of the faculty in EE/CS, but he "moonlights" as a patent attorney. He also sidelines as the feature editor of IEEE Communications Magazine, writing a monthly column, "Communications and the Law". Before coming to teach at GWU full-time, Newman worked here as a part-time professor. Simultaneously, he also worked in the field of intelligence project management and research, for over 15 years.

During the summers, he practices law. When school is in session, besides teaching, he does research in communications. He is the course coordinator of EE143, and teaches EE143 and EE144.

Dr. Newman did his undergraduate work at the University of Rhode Island and went on to Graduate school at Penn State, where he received his Ph.d in 1974. He then went to American University for his law degree.

Professor Newman is married and enjoys hiking in his free time.

*—Il H. Kim*

EULER V. UY

*Mr. Saeed Abadi demonstrates use of the Engineering School's new electron microscope.*

## Researchers Get New Electron Microscope

"WITH both upgrading and enhancing research facilities in mind, the School of Engineering and Applied Science, SEAS, has purchased a new scanning electron microscopeor SEM.

The new piece of equipment, which replaces older microscopes (circa 1960's and 1970's "antiques"), is the Cambridge System 90B. Costing SEAS about $46,000, the SEM located in Tompkins Hall is fully operative.

According to Colin Quinn, a research technician who will use SEM, "SEM's are used in materials research world-wide. It will enhance and help to develop any research in materials or other areas, including optical or microelectronics research. [It is useful with] anything that requires working with sub-micron particles or small-scale work."

Saeed Abadi, a materials researcher in Tompkins Hall pointed out that, "The SEM is the basic instrument of materials research. Basic research in this field can't be carried out without it. We can use the SEM to find the detail of the structure or the behavior of the structure and take pictures of these specimens up to 100,000 times magnification. This will be very helpful in this work."

What makes the SEM unique is the method it uses to form the image of the specimen. It uses an actual count of photons or electrons leaving a spot on the specimen that is being impacted by the electron beam. This forms a one-dimensional signal, which is easily processed electronically. The SEM completely separates the beam striking the specimen from the information signal.

The SEM, due to its great depth of field, produces a realistic 3D image. This allows for relatively easy qualitative interpretation of, for example, the topography of pieces of fractured material.

*—Jeff Winbourne*

## *Financial Aid—Are SEAS Students Getting Their Fair Share?*

GRAMM/RUDMAN, budget deficits, tuition increases . . . how will I pay for this education? This is a question on the minds of quite a few engineering students. So let's look at the facts as best they can be ascertained.

At this time, students from the School of Engineering and Applied Science, SEAS, receive about 17 percent of aid dispensed by the financial aid department. Considering engineering students are about 14 percent of the G.W.U. student body, we get more than our share. Within this figure, amounts of aid vary. The "average" aid package is $5,442 per year. If we included GSL and PLUS or ROTC aid this goes up to $6,220. Programs range from scholarships - honors and need-based, which pay one-half or full tuition,respectably, to grants, either Federal or G.W.U. administered. Moreover there are GSL, NDSC and PLUS loans, work study, and ROTC.

How have the budget deficit and Gramm/Rudman affected the financial aid program? Statistics available are for the whole financial aid program, and they are tentative. But they do show substantial cuts from last year in the federally funded programs - work study cut 17 percent, NDSL cut 12 percent and SEOG cut 19 percent. "The time of federal aid increases is gone. In the olden days," according to Laura Donnelly, Associate Director of Financial Aid here at GW, "federal aid was increased at least every 5 years. That's gone. But I hope not totally. Congressmen and Senators do have to be reelected." One area of concern Donnelly pointed out is Pell and SEOG grants. The new budget the administration has put before Congress proposes merging the

two programs, SEOG and Pell, into one, thereby effectively eliminating one of them. Some changes or increases are being discussed in Congress. These include a House bill to increase the borrowing ceiling or limit of GSL's to $5,000 during the last two undergraduate years. In the Senate, a proposal is being discussed to up the GSL amount in all 4 years of undergraduate study to $4,000 in the junior and senior years, and to increase graduate aid to $7,500 per year.

These programs are changed every 5 years under the statutes included in the Higher Education Act of 1965, signed by President Johnson. Even though there is a recognized national shortage of engineers, there are no special federally funded programs available. According to Donnelly, "the government, in the main, tries to keep special interests out of financial aid packages."

Another change occurring recently that may be of help to individual engineering students is the allocation of a special Washington, D.C. city government bond issue. From this $50 million bond issue, $18 million is reserved for G.W.U. to dispense to students over the next three years. These are called Concern Loans and they will range from $2,000-$12,000 a year at 9% interest.

The effect of Gramm/Rudman is still unclear. A 4.3% across the board cut in non-defense items is being enforced. The Department of Education has not indicated yet how it will apply this cut to its gross allocation.

The Reagan administration has been trying to cut student aid since it was first elected to office. As Donnelly stated, The priority of this administration is defense. They view missiles and hardware as defense, not education." Although this has been thwarted by Congress somewhat successfully, the future of student aid is as unclear as any "social program" at this time.

*—Jeff Winbourne*

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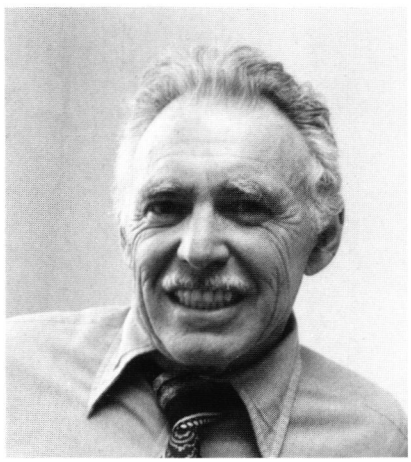
*Ms. Laura Donnelly, Associate Director of Financial Aid at GW, believes that the Reagan Administration has one priority-- defense.*



EULER V UY

*Dr. Samuel J. Raff's hobbies include seeking the origin of slang expressions and decoding bird songs.*

● ●

## Do You Know the Meaning of "The Life of Riley?"

Dr. Samuel J. Raff does. Coincidentally, Dr. Raff is also a visiting Professor in the EE/CS department. He was a student, and later worked as a part-time faculty member here at GW. Dr. Raff is the Editor-in-Chief of "Computers and Operations Research" magazine and the author of a book entitled "Microwave Systems." Closer to home, he worked as a scribe for MECHELECIV about 10 years ago.

His studies have carried him far and wide—from City College of New York, to Columbia University, to the University of Maryland, and finally to George Washington University. While he received a Ph.D. in Physics from the University of Maryland, his specialty now is microwave systems.

Previously, Dr. Raff worked for the National Science Foundation and Raff Associates, where he spent 12 years researching underwater warfare and submarines. Now, he is teaching EE20 and EE32.

Besides his technical work, he seeks the origin of slang expressions. An article entitled "The Life of Riley", an American slang expression, which has been used for more than 100 years, was published by Dr. Raff in the American Journal of Speech six years ago.

On top of all this, his interests include daily jogging, playing racquetball, and trying to somehow decode bird songs.

*—Il H. Kim*

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